

**TO STUDY THE PRESENT LANDSCAPE OF CONGENITAL HEART DISEASE
IN INDIA: EPIDEMIOLOGY, DIAGNOSTIC DEVELOPMENTS, AND POLICY
DIRECTIONS**

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By

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Under the Supervision and Guidance of

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Dear **Ms. Singh**

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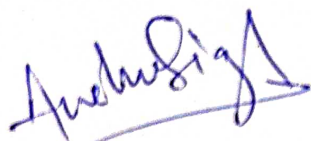
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Rakesh Valluru
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DECLARATION BY STUDENT

I hereby declare that this dissertation titled **TO STUDY THE PRESENT LANDSCAPE OF CONGENITAL HEART DISEASE IN INDIA: EPIDEMIOLOGY, DIAGNOSTIC DEVELOPMENTS, AND POLICY DIRECTIONS** is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.



(Signature)

Dr. Anshu Singh

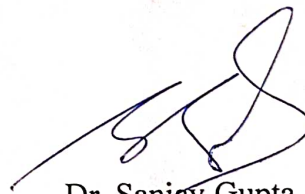
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CERTIFICATE

This is to certify that dissertation titled To study the present landscape of Congenital heart disease in India : Epidemiology , diagnostic developments and Policy directions is a record of the research work undertaken by **Dr. Anshu Singh** in partial fulfilment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.

A handwritten signature in blue ink, appearing to read 'Ashish'.

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ABSTRACT

This dissertation looks into the current scenario of CHD in India: epidemiology, diagnostic advancements, and policy interventions. A trend in diagnostic technologies and its implications and outcomes in the management of CHD should be a matter of primary concern in the research, which would have a comprehensive base of review of literature and data. This secondary research design bases its retrieved data on authoritative databases such as PubMed, Google Scholar, WHO Reports, and the Indian Paediatric Journal.

The results draw emphasis on the undercurrent of high disease burden of CHD in India and an overlay of heterogeneity and healthcare infrastructure resource constraints. Salient features from two landmark publications by Anita Saxena and Ronak Seth do point strongly toward the need for not only improvement of healthcare infrastructure but also equal, appropriate health care access. Epidemiological studies quote prevalence of 9/1,000 live births for CHD with significant regional variations across states for health care access and outcome. The need for more specialized cardiac centres and easy access to good diagnostic and treatment facilities, especially in rural and underdeveloped areas, was supported in Saxena's research.

It was critical to demonstrate the importance of early diagnosis and timely intervention in the review of clinical presentations and diagnostic technologies. Studies by Amar Taksande, Patel Zeeshan Jameel, Sakshi Sachdeva, and Saurabh Kumar Gupta have been reported to identify the foetus during prenatal life with the help of advanced imaging modalities like pulse oximetry, echocardiography, CT scans, and MRI. Most important echocardiography is the one that gives a detailed structure and function of the heart. Development of 3D and 4D echocardiography has further improved the diagnostic accuracy.

These innovations have increased the accuracy of the diagnosis and management strategies for children with CHD. According to a 2021 review by Jeremy M. Steele, Ryan A. Moore, and Sean M. Lang, cardiac magnetic resonance imaging and cardiac computed tomography have demonstrated changes that significantly enhance diagnostic precision and management outcomes for patients with CHD. In a study by the same authors in 2024,

S and Rufus discussed the utilization of deep learning algorithms in enhancing the detection of foetal CHD through ultrasound imaging, showing how AI might help advance the diagnosis and management of patients with CHD. Clinical practice guidelines and policy initiatives are pivotal means to enhance the outcomes of CHD patients. Comprehensive guidelines by Anita Saxena et al. provided evidence-based recommendations for the management of children with CHD in India, including early diagnosis, timely interventions, and structured follow-up protocols. Policy recommendations of the paper by Devyani Chowdhury et al. in India laid great emphasis on the incorporation of multi-disciplinary approaches and tele-health solutions for improved access to quality care among CHD patients. These programs will improve the delivery of health care services, especially to the rural sector, and increase the capacity of healthcare professionals in the management of CHD.

In conclusion, the present study has highlighted the dire need for continuous advancement in diagnostic technologies, strong healthcare infrastructure, and strategic policy interventions in curbing the growing CHD burden in India. The new diagnostic modalities and equity in access to health care must be integral parts of any program to improve management of CHD and the outcome of patients.

Keywords: Congenital Heart Disease, Diagnostic Technologies, Healthcare Infrastructure, Policy Interventions, India

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Sincerely

Dr. Anshu Singh

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ABBREVIATIONS

CHD	Congenital Heart Disease
CMR	Cardiac Magnetic Resonance Imaging
CCT	Cardiac Computed Tomography
AI	Artificial Intelligence
LMIC	Low- and Middle-Income Countries
CT	Computed Tomography
MRI	Magnetic Resonance Imaging

Evaluating the Impact of Technological Advancements in Cardiac Diagnostics on the Management of Congenital Heart Disease in India

1. INTRODUCTION

1.1 Background

Thus, CHD is recognized as one of the most critical public health problems in the context of worldwide tendencies, affecting paediatrics substantially(1). It comprises a very extensive range of architectural and physiological abnormalities concerning the heart and the blood vessels that emerge at childhood with varying degrees of severity and acuteness (2). This is because, whereas diagnostic and surgical interventions on patients with CHD have become progressively refined, managing and caring for CHD patients requires identification of the disease process early, and ongoing patient care with interventions over the lifespan that include diagnosis, care, and treatment.

However, congenital heart disease as a disease has a social impact on family and caretakers because patients' needs are a major emotional, financial and even social issue. These issues raise the argument that CHD and all the ways to treat it as well as the likelihood of the outcomes can influence patients and the persons and groups, they turn to for assistance strongly and on the personal level. Hence to meet the existing, multi-faceted needs of a child diagnosed with the disorder and other needs that might arise for the need of its care besides enhancing the psychological health of a CHD patient and that of the family, very intense and synchronized interferences and support from the society are vital.

1.2 Epidemiology of CHD:

CHD has been one of the most global born-defect conditions that is prevalent in individuals irrespective of their age and nationality; however, the global statistics are close to millions (3). According to WHO it is calculated that about Newborns are the most hit as 1.35 million of them are born with CHD annually hence the significant cause of mortality and morbidity in children and infants (4). But as for the evidential data on the distinction of the specified sickness in various territories, it is noteworthy that the occurrence of this disease is at a higher percentage in developed states, compared with the low and middle-income countries. However, discrepancies in access to health care,

ratio, and techniques for diagnosing CHD, and the differing ways of reporting tend to mask the possible honed characteristic of the prevalence feature of CHD even more, particularly in the developing nations.

The burden of CHD, therefore, in LMICs, which includes India, is high, with estimated atelectasis prevalence ranging from 8 to 12 per 1,000 live births. Underreporting and difficulty in diagnosis likely underestimate the true prevalence (5). In addition, rapid urbanization, environmental pollution, genetic predisposition, and high rates of consanguineous marriages increase the risk for congenital anomalies and cardiovascular diseases, hence increasing the burden of CHD in India (6).

It is further supported by the epidemiology of CHD, a clear requirement to address socio-economic determinants of health—strong drivers of diseases and their outcomes. On the other hand, suboptimal access to health care interacts with deep-seated poverty and inadequate infrastructure, along with the suboptimal diagnosing and management of CHD to mean disorder in low- and middle-income countries like India. Inadequate prenatal care also leads to a part of this burden of CHD, mostly in poor communities, because of poor nutrition and lack of antenatal screening. It is of importance to address these socio-economic factors using targeted interventions and policy initiatives if the impact of CHD is to be reduced, and for health equity of all affected individuals.

1.3 Context in CHD within the Indian Condition

In the Indian subcontinent, which holds a large and heterogeneous population, the burden of CHD is driven by a wide array of factors, such as genetic predispositions, environmental exposures, and socio-economic determinants. There is a remarkable regional heterogeneity compared to its prevalence in other parts of the country, reflecting genetic susceptibility, environmental risk factors, and access to healthcare (7). For example, some studies have reported higher prevalence rates of CHD from parts of India, including Kerala and Rajasthan, which probably reflect geographic variations in disease burden or risk factors.

Moreover, socio-economic factors impose a major influence on the usual epidemiology and outcome of CHD in India. This is due to limited access to prenatal care, poor maternal nutrition, and inadequate antenatal screening that often leads to late diagnosis and bad outcomes in infants with CHD (8). Socioeconomic inequalities like poverty, illiteracy,

and no health insurance coverage also widen inequities in the management of CHD, leading to a failure to get timely diagnosis, treatment, and surgical intervention in rural and disadvantaged regions of the country. This challenge calls for targeted interventions and policy initiatives to intervene in unmet needs for CHD patients all over India. Moreover, cultural beliefs and practices also influence the perception and management of CHD within the Indian context (9). Traditional beliefs about the causes of illness, such as karma or fate, may impact help-seeking behaviours and treatment adherence among affected individuals and their families. Additionally, stigma surrounding congenital anomalies and disabilities may contribute to social isolation and discrimination, further exacerbating the psychosocial burden experienced by CHD patients and their families. Recognizing and addressing these cultural nuances is essential for delivering culturally sensitive and effective care to individuals affected by CHD in India.

1.4 Challenges in CHD Management

The diagnosis and management of CHD in India is multi-faceted, with diagnostic delays and limited access to dedicated care, financial constraints, and poor infrastructure for health care (5). While the western world has paediatric cardiac comprehensive centres galore, India has gross deficiencies in trained paediatric cardiologists and cardiac surgeons and related healthcare personnel in the rural sector (10). This shortage brings out the need for strategies in workforce development and capacity-building, which can improve care delivery for CHD across the country.

More than this, the management of CHD in India remains muddled due to limited access to diagnostic and treatment facilities, thereby increasing health inequity through inequities in healthcare infrastructure (11). While the bigger metropolitan cities may host tertiary care centres with state-of-the-art cardiac imaging and surgical facilities, this kind of access is quite low in rural and semi-urban areas. Coming now to the most discernible consequences of such inequality, large numbers of patients with CHD experience formidable obstacles in their efforts to get access to timely, proper care, hence suffering delayed diagnosis and suboptimal management.

Moreover, diagnosis and treatment are very expensive, and long-term care is needed, making the management of CHD very complex. The financial resources of many families in India are limited to afford specialized medical services and surgeries for CHD. Although government-sponsored insurance schemes and other financing initiatives do

exist, treating CHD is extremely expensive and drains the pockets of families, forcing them either to forgo lifesaving health care or at best incur crippling debt. Indeed, financial barriers to the management of CHD call for a multi-faceted approach that addresses broadening access to affordable healthcare services, including subsidizing treatment costs and mitigating these financial burdens on vulnerable groups affected by CHD.

1.5 Government Initiatives and Policy Implications

In view of the magnitude of the burden of CHD in India, the government has initiated several projects to strengthen paediatric care services and decrease the occurrence of birth defects. Under the Universal Health Screening for children from 0-18 years, the RBSK Programme is being implemented under NHM, which includes screening for birth defects, including CHD (12). Government-financed health insurance schemes, such as Ayushman Bharat, have the objective to reduce the financial burden of accessing quality health care services and to protect financially vulnerable groups, including children with CHD (13).

Besides the efforts taken by the national governments, various NGOs and philanthropic societies have been engaged in actively meeting up the challenges thrown by CHD management. These organizations often collaborate with the government agencies, health service providers, and societal stakeholders to undertake community-based screening programs, ensure sponsorships toward treatment, and generate awareness about prevention and management of CHD. These NGOs complement the efforts of the government through their grassroots-level networks, mobilization, and resultant leveraging in resources, filling deficit services in the healthcare chain—especially in areas segregated or peripheral where it is rather difficult to avail access to specialized care. However, scaling up would need continued support and collaboration among government entities, NGOs, and stakeholders to give most children in this country a fair access to CHD care.

1.6 Purpose of the Study

i) Epidemiology of CHD in India

CHD is one of the major public health problems in India and affects people of varied demographic backgrounds (5). The present research fully looks into the epidemiological scenario of CHD with respect to the Indian context, i.e., prevalence rates of CHD, regional

disparities, and causes that lead to this disease. While making a careful review of the existing literature and data in this regard, the present study takes the aims at bringing out major trends and patterns in the occurrence and distribution of CHD under different demographic and geographic settings. Such epidemiological factors should be taken into consideration if the targeted interventions and policies are to succeed in reducing the burden of CHD in India. The present study will thus explore the epidemiology of CHD with respect to assessing the birth prevalence of the defect, including severe cases that usually require immediate medical interventions. The variations in the prevalence of CHD in the different regions of India will also be investigated. In this case, it looks at variables such as urban versus rural setups, socio-economic status, and access to health services. In that context, there is the essence for the study to look at variables that will identify areas with the most pressing needs in terms of medical infrastructure and consequently developing health programs that will be targeted.

ii) Diagnostic and Treatment Practices

This will be a critical objective of the study: to assess current diagnostic and treatment practices for CHD in India. In terms of early diagnosis and effective management, diagnostic technologies such as echocardiography and cardiac MRI, among others, are important and have to be widely available and easily accessible (14). The study will review the literature and empirical evidence that exist on the availability and utilization of these diagnostic tools across various healthcare settings in India.

In this regard, treatment facilities and surgical interventions that exist in India for patients with CHD should be understood. It will explore the quality and the outcomes of the treatments with respect to inequalities between different health providers, including public and private sectors. The barriers and challenges that precede timely diagnosis and optimal management of CHD should also be located. These would include infrastructural matters about healthcare, the availability of trained medical manpower, financial constraints, and cultural factors that would influence healthcare-seeking behaviour.

The study highlights the lacunae in diagnostic and treatment practices with insights on how overall management of CHD can improve in India. The recommendations for this broadly pertain to increasing the training of health professionals, making advanced

diagnostic tools available, and also making treatments accessible and available to all in time, like beyond socio-economic groups.

III. Socioeconomic Determinants

The research also targets the examination of socioeconomic determinants of CHD management outcomes in India. The access to healthcare, level of education, and poverty conditions affects the most about the frequency, diagnosis, and course of therapy of CHD (15). By giving an overview of qualitative data and literature reviews, this study shall be able to set out how these socio-economic factors affect health outcomes in regard to patients with CHD.

It can help in the development of effective interventions and policies by understanding the implications of socio-economic factors. For instance, poverty may mean no access to health facilities and therefore lead to late diagnosis and treatment for CHD. Likewise, having insufficient education, professionals may opt to practice in disregard for the disease and the need for early admission to the hospital. This means identifying such barriers to inform targeted interventions that will help address these challenges and improve health outcomes for patients with CHD in India.

The qualitative analysis will explain how these socio-economic factors influence various stages of CHD management at different levels, starting from early detection to continuing treatment and follow-up care. This would consist of case studies and reports citing the experiences of patients diagnosed with CHD and their families in order to present an all-dimensional understanding of real-life challenges faced by them.

iv) Implications for Policy

Another long-term objective of this research would be to extract policy implications and, consequently, recommendations for improving management and outcomes of CHD in India. Evidence-based recommendations that would come out from the synthesized findings of reviews of literature and empirical studies would serve to guide policymakers, health providers, and other stakeholders in improving CHD care.

Such recommendations can embrace mechanisms of. The health infrastructure is another area that the study would like to see improved, more so in specialized heart care centres—plans to have many such centres and have equal distributions across the country. The study might also be able to recommend and suggest increasing accessibility to more advanced diagnostic and treatment technologies to be available to all patients irrespective of their socio-economic status.

Other main recommendations can include community-based interventions aimed at raising awareness about CHD and its early diagnosis, besides providing timely and appropriate treatment for patients suffering from the disease. Hence, the study will emphasize the promotion of health equity or, in other words, ensuring that quality health care is provided to all patients suffering from CHD regardless of background.

It also aims to advocate for the current need to develop and implement national guidelines about the management of CHD. These can be used to uniform treatments offered to patients with CHD and so enhance homogeneity and quality in varied healthcare settings. Such guidelines, by giving a clear framework for the diagnosis, treatment, and follow-up care of CHD, may improve patient outcomes and reduce the burden of CHD in India.

2. REVIEW OF LITERATURE

S. No.	Specialization	Author (Year)	Salient features
1.	Congenital Heart Disease in India: A Status Report	Anita Saxena (2018)	The present study has taken up a current update on the situation regarding CHD in India, elaborating on its epidemiology and current cardiac care available for children affected by this anomaly. CHD is considered to be the commonest congenital anomaly and accounts for a significant fraction of all birth defects. The birth prevalence in India is reported to be 8 to 12 per 1,000 live births. The number is approximately about 240,000 infants born with CHD within a year. Although the frequency is high, advanced cardiac care is grossly inadequate, especially in low- and middle-income nations like India. This study compares pediatric cardiac care in affluent nations to that in LMICs, pointing out the poor access to appropriate specialized healthcare facilities, shortages of appropriately trained physicians, and financial barriers to care faced by families. It showcases the dire requirement for targeted therapies, increased awareness, and improved

			infrastructure in healthcare to battle the ever-increasing prevalence of CHD in India. It also describes the attempts of the Indian government in improving the health status of children and different programs and strategies that can be set up to help children suffering from CHD, especially in the backward and slum areas. These programs attempt to bring about a difference that will alleviate the inequality in accessing health care by extending equal care to all children suffering from CHD, taking into account the medical and socio-economic barriers to be overcome to improve the outcome in these vulnerable groups (5).
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2.	Conquering Congenital Heart Disease in India: Need for a Long- term Vision!	Ronak Seth (2023)	This paper, therefore, underlines the need for adoption of a comprehensive strategy for tackling CHD in India, taking into consideration the twin imperatives of public sector capacity building and equal access to health services. It further underscores that these collaborative efforts between the public and private sectors remain essential toward development for the effective management of CHD and calls for a paradigm shift. A paradigm shift in integrating health care delivery, training, and research in paediatric cardiology is necessary. Proposals include dedicated academic departments of paediatric cardiology, CoE across regions and replication of successful models to foster indigenous innovation in cardiac technologies. This is coupled with calls for a coordinated effort led by Institutes of National Importance for the creation of a robust public sector continuum for paediatric cardiac care. This continuum addresses all requirements, from early detection through newborn screening programs to timely medical interventions and holistic follow-up care for the optimal long-term health outcomes of children
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			with CHD. Therefore, this paper calls for transformative changes that will make a big difference in terms of quality of care and overall management for CHD across India(15).
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3.	Critical Congenital Heart Disease in Neonates: Review Article	Amar Taksande and Patel Zeeshan Jameel A (2021)	This review provides a comprehensive overview of critical congenital heart defects in neonates, reflecting the impact of this neonatal condition as the leading cause of neonatal mortality and morbidity. The article highlighted those clinical manifestations of CCHD, which included shock, cyanosis, and respiratory distress, that may be symptoms compatible with other conditions in neonates, placing a great deal of importance on early diagnosis to avert acute cardiovascular collapse and mortality. This article focuses on the effectiveness of regular pulse oximetry screening for CCHD and other hypoxemic conditions in neonates in time-bound intervention that will be life-saving. Besides, it discusses the therapeutic role of continuous PGE1 infusion in stabilizing neonates with clinical deterioration prior to access to echocardiography. This review has taken an overall succinct synthesis of the current presentation and management strategies for CCHD, stressing the critical need for early detection in order to optimize patient outcomes and reduce this
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			burden of complex congenital anomalies on neonatal health. (16)
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4.	Imaging Modalities in Congenital Heart Disease	Sakshi Sachdeva and Saurabh Kumar Gupta (2020)	The current article elaborates on the central role that cardiac imaging has played in the management of CHD—an area that continues to add to the ever-growing list of reasons behind its transformative impact on patient outcomes—and places special emphasis on the progress made toward cardiac imaging techniques to improve diagnosis and treatment for patients suffering from CHD. Echocardiography is the cornerstone imaging modality, given that it is a noninvasive technique able to provide real-time information about cardiac structure and function. The authors also acknowledge the complementary roles for noninvasive cross-sectional imaging modalities that include magnetic resonance imaging and computed tomography, both of which are used to advance detailed morphologic and physiologic evaluations necessary for the diagnosis and long-term care of CHD patients. While it is an invasive procedure, cardiac catheterization remains, up to this day, a technique considered irreplaceable for accurate hemodynamic assessment and percutaneous interventions—further optimizing patient care. In
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			this respect, the review shows the continuous evolution of visualization techniques that keep fostering and broadening diagnostic capabilities of these imaging modalities to improve their clinical utility within the personalized strategy of CHD management. Essentially, therefore, this review article is on the various techniques for cardiac imaging in the diagnosis and therapeutic management of CHD and highlights their collective role in the improvement of patient outcomes and guiding clinical decision-making (17).
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5.	Diagnosis and Management of Critical Congenital Heart Diseases in the Newborn	Mani Ram Krishna and Raman Krishna Kumar (2020)	This review article gives detailed information on the diagnosis and management of critical CHD in neonates, against the background of neonatal mortality's contribution to the context of mortality reduction by improved medical care. It places the new focus on neonatal CHD recognition and intervention in the context of declining mortality rates from other conditions. It does acknowledge the gains made in most states regarding diagnostic and interventional facilities for critical CHD, supplemented by improvements in surgical techniques and post-operative care that significantly improve survival rates and quality of life of neonates affected by the problem. While this is the case, if neonatal mortality is to be prevented, earlier detection is paramount, and hence it behoves a neonatologist/paediatrician to be at all times watchful for the occurrence of CHD in neonates. It describes the context-oriented practical strategies targeted at improving the prognosis and outcomes of neonates with critical CHD. The major emphasis is on timely intervention, multidisciplinary care approaches,
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			and timely intervention. This comprehensive review brings out the current scenario of management of critical CHD, including the challenges, recent developments, and strategies aimed at optimizing care and improvement in outcomes for neonates affected with such life-threatening conditions (18).
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6.	Examining ultrasound pictures to identify congenital cardiac abnormalities in foetuses	Satish S and N Herald Anantha Rufus (2024)	The early diagnosis of CHD during pregnancy is very important to reduce mortality and morbidity rates related to the condition. This work investigates the use of ultrasound imaging for early identification of CHD. One acknowledged limitation of the current screening technologies—often yielding a low detectability rate—is what, at times, warrants the exploration of foetal ultrasound image evaluation with the help of deep learning techniques for diagnostic accuracy enhancement. Advanced technologies in ultrasound image-based CHD detection are reviewed, focusing on foetal ultrasound imaging as the non-invasive potential complementary diagnostic tool to traditional foetal echocardiography in picking up CHD. These include preprocessing methods, which include spatial domain filters and transform domain filters, and denoising techniques using Convolutional Neural Networks (CNNs). The segmentation strategies discussed in this investigation include thresholding and region growing methods, edge detection methods, and application of Artificial Neural Network and
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			deep learning techniques for improving the methodologies in detecting CHD. This paper also tries to open up all possible future avenues of research leading to further improvement of the presently ultrasound-based diagnosis methodologies for CHD and hence stresses the need for continuous improvement in the diagnostic capabilities and outcomes for prenatal cardiac healthcare (19).
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7.	Artificial Intelligence in Paediatric Cardiology: A Scoping Review	Yashendra Sethi, Neil Patel, Nirja Kaka, Ami Desai, Oroshay Kaiwan, Mili Sheth, Rupal Sharma, Helen Huang, ⁸ Hitesh Chopra, Mayeen Uddin Khandaker, Maha M. A. Lashin, Zuhail Y. Hamd, and Talha Bin Emran (2022)	The use of AI in healthcare has been changing everything—as from the automation of vital processes in healthcare such as diagnosis, risk assessment, and management to work-load reduction for healthcare professionals with reduced errors. The authors have done a reviewing literature search between 2002 and 2022 regarding the area of research, showing how neural networks and machine learning techniques enhanced diagnostic accuracy in almost all types of imaging modalities, including cardiac MRI, echocardiograms, CT scans, and ECGs. AI-driven prediction algorithms have also shown potential in improving post-operative outcomes and increasing prognostic accuracy within paediatric cardiac surgeries. This review places much emphasis on the feasibility of applying AI to prenatal prediction and early detection of CHD from EMRs, particularly concentrating on maternal risk factors. This potential of AI to change the face of paediatric cardiology, however, acknowledges major challenges: limited algorithm availability, insufficient physician training, and
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			concerns regarding excess mechanization and how this would be accompanied—probably—a loss of human-centred care. Notwithstanding these difficulties, the authors regard AI assuming a leading role in advancing precision cardiology by virtue of error-free and streamlined health care solution that it offers in CHD management quite within the realm of near future possibilities (20).
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8.	Advanced cardiac imaging's application in congenital heart disease: development, indications, and advancements	Jeremy M Steele, Ryan A Moore and Sean M Lang (2021)	This review article provides an overview of the evolution and applications of advanced cardiac imaging innovations in patients with CHD. It attempts to give an insight into the huge strides in diagnosis and management for CHD to date, which has led to improved survival rates, necessitating lifelong noninvasive assessment. Diagnostic requirements of the CHD patients are complex, and so reliance is increasingly being placed on new imaging techniques like cardiac computed tomography and cardiac magnetic resonance imaging. Recent studies oriented to the purposes of these modalities have revealed an increasing trend of use, but special attention has been paid to the refinement of techniques in CMR methods to overcome the problems inherent in the earlier approaches and to enable the examination to be performed more quickly—this being especially important in pediatric cases or those with more serious conditions. Current CCT research is geared toward enhancing the quality of images while reducing radiation exposure, fundamental to the preservation of patient safety and
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		health outcomes. This paper looks at how digital revolutions have been changing three-dimensional imaging through virtual and augmented reality platforms for better view and planning of surgeries for accuracy. This paper also presents discussions on the formation of guidelines for use to ensure prudence in the application of advanced imaging tools within clinical practice. This review therefore concludes that advanced cardiac imaging is increasingly integrated into the care of patients with CHD, and not only requires but definitely necessitates expertise and even familiarity among healthcare providers in order to achieve the best diagnostic precision and therapeutic outcomes at all times (21).
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9.	Updated and revised consensus statement of the Working group on congenital heart disease management provides advice for Indian patients regarding common congenital heart disease reasons and timing of interventions.	Anita Saxena et al., (2019)	Guidelines from India should, therefore, be able to delineate indications and timing for intervention in common CHDs and provide evidence-based approaches for the management of these complex conditions in children countrywide. These recommendations address, in a comprehensive way, the timing for surgical or catheter-based interventions and post-procedural follow-up, indications for pacemaker implantation in paediatric CHD patients with coarctation of the aorta, tetralogy of Fallot, total anomalous pulmonary venous connection, Ebstein's anomaly, VSD, pulmonary stenosis, aortic stenosis, and aortic stenosis and pulmonary stenosis. Specifically adapted to the Indian context, these recommendations were tailored to modify the management and outcomes of CHDs by accommodating unique challenges like delayed diagnosis, prevalent comorbidities, and nutritional deficiencies prevalent in the population. Specifically, these guidelines are meant to standardize care practices, improve the efficacy of treatment, and finally enhance quality of life for infants with
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			congenital heart abnormalities by offering organized guidelines based on current medical data and clinical knowledge accrued till date across the country (22).
10.	2020 Perspective on Our 2030 Future with Regard to Health Care Policy and Congenital Heart Disease	Devyani Chowdhury et al., (2021)	The paper provides an in-depth analysis of the myriad issues confronting the congenital heart community along with a comprehensive framework of advocacy and policy actions designed to mitigate these issues. It focuses on three main dimensions: the discourses that deal with the population with a patient population, healthcare delivery, and workforce dynamic dimensions. It

			clearly discusses the deep impact of social determinants of health and health care disparities on individuals with CHD, mostly highlighting how difficult it can be for adults to manage CHD and other chronic conditions. The paper serves as an impetus to take multidisciplinary care approaches where diverse medical specialties will be integrated with a focus on patient-centered models of care. This would increase accountability and result in a gain in quality of care. Telehealth has become instrumental in overcoming geographical barriers to access specialized care and enhance health outcomes in children with CHD. This article also provides a critical review of the current status of provider training · Discusses the promotion of enhanced workforce diversity and improved competence in the management of congenital heart disease across diverse patient populations. It underlines the patient–family-centered organizations that play the lead in advocating and promoting support programs that safeguard the protection of rights and interests of patients with CHD. Finally, the paper provides a strategic layout of
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			how upscale changes in policy level and advocacy within congenital heart care were addressed for change toward engendering an inclusive and effective healthcare system that is responsive to the evolving needs of CHD patients over a ten-year period (23).
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3.METHODOLOGY

3.1 Research Design

This dissertation has adopted a secondary research design to determine exactly how evolved cardiac diagnostic technologies impacted the treatment of CHD in India, if at all. It does this through the detailed review and subsequent analysis of available data, studies, and literature. The secondary nature of this research was particularly suited for this study since it gave an in-depth understanding of the issue without the ethical and logistic issues of collecting primary data.

3.2 Research Question

What are the current trends in diagnostic technologies and policy interventions for managing congenital heart disease in India?

3.3 Objective

To analyse the current landscape of congenital heart disease (CHD) in India.

3.4 Data Sources

Data is sourced from reliable databases including PubMed, Google Scholar, WHO reports, and the Indian Paediatric Journal.

3.5. Inclusion and Exclusion Criteria

The following inclusion and exclusion criteria ensure that only quality data as well as relevant data are included:

Inclusion Criteria:

- i. Published in peer-reviewed journals.
- ii. Research about CHD and cardiac diagnosis, meta-analyses, reviews, and articles.
- iii. From 2010 onwards, to have data relevant for current technologies and practices.
- iv. Research specific to the Indian health context.

Exclusion Criterion:

- i). Non-peer-reviewed articles and expert opinions.
- ii). Studies more than 10 years old unless they are those of fundamental knowledge.
- iii). Research not directly related to Cardiac Diagnostics or the management of CHD.
- iv). Articles not in English.

3.6 Data Collection and Analysis

The data will be collected through a systematic search of the chosen databases based on the following keywords: "cardiac diagnostics", "congenital heart disease", "India", "echocardiography", "MRI", "CT scans", and "AI". Boolean operators are used to further optimize the search to ensure it fully covers the topic.

The collected data will then be reviewed and synthesized with care. The key steps here entail:

- i). Identification:** Making a list of all studies and publications relevant to the area of interest chosen, as per the inclusion criteria.
- ii). Screening:** Reviewing the abstract and full text for relevance to the study's aims and objectives and the inclusion criteria.
- iii). Eligibility:** Assessing the methodological quality and relevance of each study
- iv). Data Extraction:** Extract relevant information on design, sample, measurements, findings, and conclusion.
- v). Synthesis:** Avail the findings, and Baseline and identify common Themes, Trends, and Gaps in the literature.

This study primarily focuses on the relationship between advanced cardiac diagnostic technologies and early detection, treatment outcome, and management of CHD in India. A second question then brings out the challenges to the adoption of these technologies and possible strategies to surmount the barriers in place.

3.7 Ethical Considerations

Ethical issues primarily revolve around crediting and properly referencing the work of the original authors since this is a secondary research study. All sources are properly

referenced in the Vancouver style of referencing not only to avoid plagiarism but also to safeguard the integrity of the academia.

3.8 Limitations

Although secondary research has many benefits, it also has its inherent limitations that need to be kept in mind:

i). Potential Bias: Bias may be inherent in the included studies by design, participant selection, or funding source.

ii). Variability in Study Designs: This review presents variation in methodologies across the studies. Such complicates comparability and generalisability.

iii). Publication Bias: Studies that go on to find good results are more likely to be published than those that get negative or ambiguous results—a phenomenon called publication bias.

iv). Lack of Primary Data: This dependence on published literature is at the expense of primary data collection, which would limit detailed information gathering in order to review certain aspects of cardiac diagnostics and CHD management.

4.RESULTS

4.1 Introduction

The burden of CHD, which is such an important and complex global health issue, is thus very heavy in India, a country with enormously large population diagonally diversified by heterogeneous healthcare resources. This dissertation critically assesses the deep impact of recent technological advancements in cardiac diagnostics on the management of CHD in India. This paper seeks to eliciting in-depth information against the backdrop of available literature on epidemiology, healthcare infrastructure, diagnostic technologies, guiding principles of management, and policy initiatives that take shape in an evolving landscape of CHD care in India.

4.2 Epidemiology and Healthcare Infrastructure

An important contribution to the epidemiology came in through the seminal work of Anita Saxena in 2018, shedding light on the prevalence of CHD and the substantial challenges it poses in the delivery of comprehensive care in low- and middle-income settings. According to Saxena, at birth, the risk of CHD is estimated at 9 per 1,000, comparable with global estimates; however, due to the huge population, the burden is bigger by much. Distribution of infants born with congenital heart diseases in different regions of India every year [Fig. 1]. Saxena underscores the dire need for strengthened healthcare infrastructure to combat the increasing burden of CHD within the country. The congenital heart disease is hitting all the major regions of Indian, that is,. North, South, East, West, Central and Northeast but still only a very less proportion of them are getting treated [Fig 2]. It thus proved the requirement for more specialized cardiac centres and also better accessibility to the diagnostic and treatment facilities especially to the rural and under-developed areas (5).

The 2023 view of Ronak Seth is to support this with a sustainable strategy of capacity building in the public sector and, accordingly, provide access to care equitably. His emphasis has been on bringing CHD care into the mainstream of the public health agenda and strengthening training programs for health professionals (15).

It also goes in tandem with the findings of Saxena, with added emphasis on the more permanent measures in improving healthcare delivery for the diverse demographics affected by CHD in India (5). Lastly, Seth sheds light on the works of government

initiatives and non-governmental organizations concerning the urban-rural divide in healthcare services, pointing out that a greater share in funding and resources can work wonders in improving rural healthcare infrastructure and thereby CHD management outcomes.

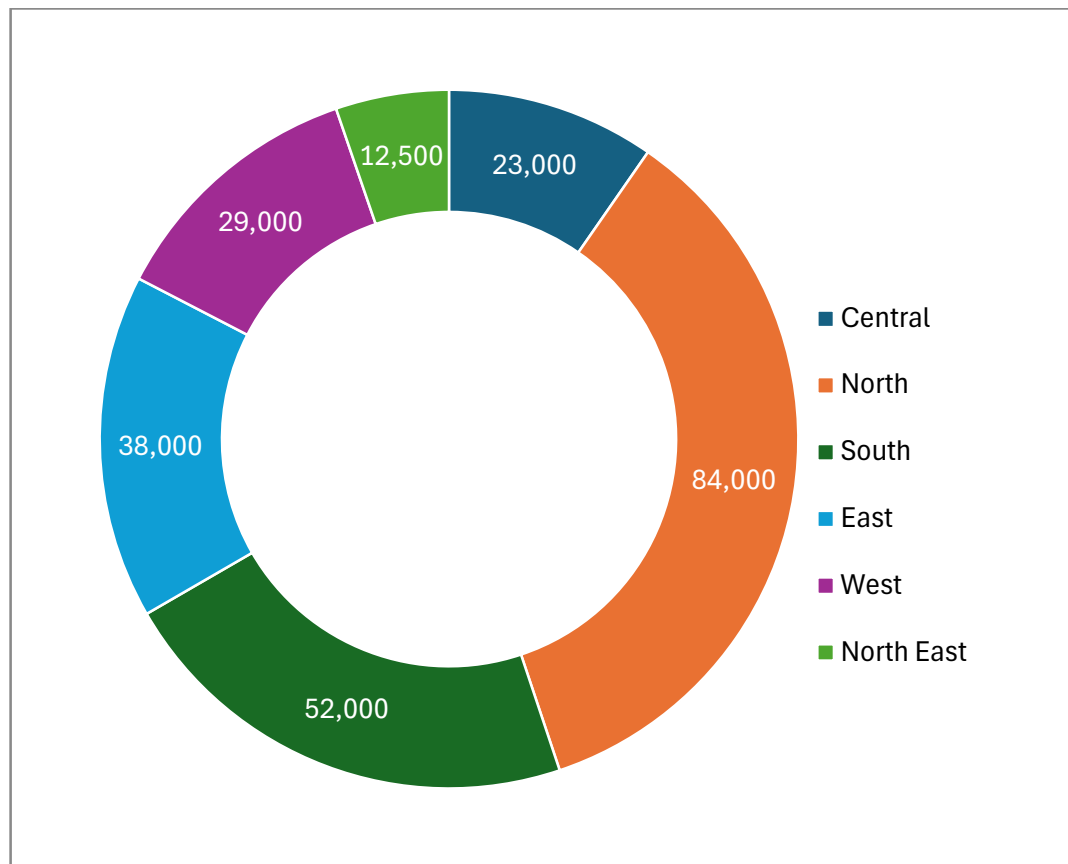


Fig. 1 Distribution of infants born with CHD in different regions of India every year.
(Source: Saxena A. Congenital Heart Disease in India: A Status Report.)

(5)

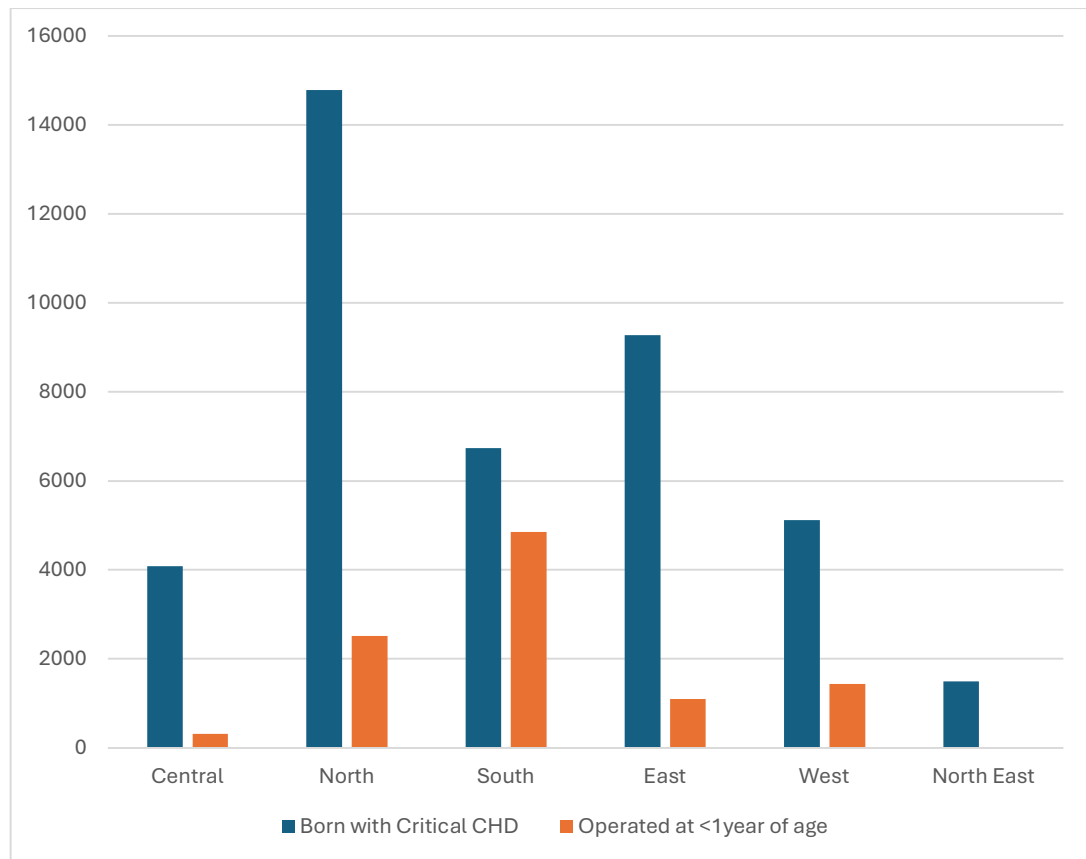


Fig. 2 Distribution of infants with critical heart disease accessing surgery as compared to total infants born with critical heart disease. (Source: Saxena A. Congenital Heart Disease in India: A Status Report.)

4.3 Clinical Presentation and Diagnosis

There is a well-written review article by Amar Taksande and Patel Zeeshan Jameel, 2021 that considerably throws light on clinical presentations of critical CHD in neonates, focusing mainly on the role of early diagnosis with prompt intervention. Their study has shown that early prenatal detection and timely intervention are cornerstones to reduce morbidity and mortality related to CHD. For example, pulse oximetry screening has been recognized as one of the simplest yet most effective tools for early identification of critical

CHD in infants, which has been lifesaving when followed by timely medical or surgical intervention (16).

An article by Sakshi Sachdeva and Saurabh Kumar Gupta from 2020 explains that an important role in the differential diagnosis belongs to advanced imaging modalities: echocardiography, computed tomography, and Magnetic Resonance Imaging. Echocardiography has some undisputed advantages in diagnosis because of the high details about heart structure and function. The development of 3D and 4D echocardiography substantially increased accuracy in diagnosis (17). The table below summarizes the main imaging modalities applied in the diagnosis of CHD and major areas of application:

Table 1: Key Imaging Modalities in CHD Diagnosis

Imaging Modality	Primary Applications
Echocardiography	This will allow for the structural and functional assessment of the heart, real-time imaging, and foetal heart evaluation.
CT scans	Precise anatomic imaging, vascular structures, planning of interventional procedures
MRI	Detailed anatomic and functional imaging; investigation of tissue properties of myocardium.

Advances in imaging technologies have significantly improved diagnostic accuracy and guided appropriate management strategies for patients with CHD in India. These help in not only early detection but also in detailed anatomical and functional assessment needed for surgical or interventional procedures.

4.4 Technological Innovations

A 2021 seminal review by Jeremy M. Steele, Ryan A. Moore, and Sean M. Lang describes such transformational advances in cardiac imaging technologies, with particular emphasis

on how cardiac magnetic resonance imaging and cardiac computed tomography have made great strides toward better diagnostic accuracy and enhancement of management outcomes for CHD patients. Like their own peer group, the CMR provides detailed information on heart structure, function, and tissue characterization without radiation exposure and is ideal for repeated evaluations in paediatric populations. CCT is indicated in Ali's case for its fast acquisition times with high-resolution images that offer detailed anatomic assessment and pre-surgical planning (21).

The 2024 study by S and Rufus investigates one of the most promising applications of deep learning techniques to enhance the detection of foetal CHD through ultrasound images, therefore underlining how diagnostic methodologies have been constantly changing. According to the findings presented in their work, deep learning algorithms, coupled with traditional ultrasound imaging, increase the sensitivity and specificity of foetal CHD detection significantly (19).

A 2022 scoping review by Yashendra Sethi et al. further discusses the potential for AI in paediatric cardiology. Integration in this field of medicine may be huge in the automation of critical aspects of care delivery and raises diagnostic acuity. AI-driven tools can analyse large amounts of imaging data at rapid rates to provide insights that might be overlooked by human eyes. Although challenges in limited algorithm availability and requiring comprehensive physician training were indeed acknowledged, they note that these findings do hold promise for the use of AI to revolutionize the management of CHD in India through innovative diagnostic approaches (22).

4.5 Guidelines and Policy Initiatives

Comprehensive guidelines due to Anita Saxena et al., dated 2019, provide evidence-based recommendations on the management of CHD in children of India. In this regard, these guidelines pinpoint the best timing for interventions and set structured follow-up protocols, so they turn out to be very helpful for Indian health professionals in clinical decision-making in order to improve further the outcomes in patients. These guidelines have emphasized an early diagnosis, timely surgical or catheter-based intervention, and regular follow-up regarding residual lesions monitoring and management for possible complications. (22).

Devyani Chowdhury et al. proposed key advocacy and policy initiatives that must be addressed regarding the delivery of care for CHD in India (23). Their framework provides significant emphasis on the need to adopt multidisciplinary approaches and the help of telehealth solutions in improving access to quality care among CHD patients. Their proposed initiatives thus proportionately proffer a strategic road map for policymakers and other healthcare key stakeholders in strengthening management practices on CHD over the next decade. The following table summarizes critical policy recommendations and the targeted impact in brief.

Table 2: Policy Recommendations and Intended Impact

Policy Recommendation	Intended Impact
Strengthening rural healthcare	Improved access to rural CHD diagnostic and treatment facilities.
Training programs for healthcare professionals	Improved skills and knowledge in the management of CHD.
Integration of telehealth	Increased access to specialized care and follow-up services

Conclusion

Literature review done more comprehensively suggests that current technological developments and policy measures have opened up boundless potential for improving the management of CHD in India. With timely exploitation of advanced diagnostic technologies, adoption of evidence-based guidelines that work in favour of progression, and a serious advocacy for progressive policy reforms, it becomes feasible to have a major impact on the prevailing standards of healthcare delivery, reduction in morbidity and mortality rates, and improvement in the quality of life in those suffering from CHD. However, the translation of these insights to affect a tangible behaviour change at the

level of clinical practices and healthcare policies within the very diverse landscape of Indian healthcare requires sustained research efforts and collaborative endeavours.

5. DISCUSSION

5.1 Interpretation of Results

This dissertation critically reviews the impact recent technical developments in cardiac diagnostics have had on the treatment and results for CHD in India. From available evidence, such developments exert a multifarious influence across epidemiology, health infrastructure, clinical presentation, diagnosis, technological innovations, and policy initiatives relating to CHD care.

Starting from epidemiology and the structure of healthcare, the landmark study by Anita Saxena has put forward the prevalence of CHD in India and the declaration of huge challenges for delivering comprehensive care in a resource-poor setting. Saxena underlined that prevalence estimates of CHD was a major public health challenge in India, which estimated that annually, around 240,000 children were born with CHD. The study points out serious gaps in health infrastructure that daunts effective CHD management in rural and resource-poor areas of the country (5). It is in this regard that the point made by Ronak Seth comes in handy: sustainable strategies for building capacity in the public sector have to ensure equal access to care for Cardiac Human Defect. Seth's comment emphasizes that the blueprint of public health is strong, and this provides a good framework for reducing disparities in healthcare access and quality so that CHD children get timely and appropriate care regardless of their varied socioeconomic backgrounds (15).

Therefore, on clinical presentation and diagnosis, papers by Amar Taksande and Patel Zeeshan Jameel, Sakshi Sachdeva and Saurabh Kumar Gupta, would say that the advanced imaging modalities like echocardiography, computed tomography, magnetic resonance imaging, and AI-driven techniques are very relevant in the enhancement of early detection and timely intervention in patients with CHD (16,17). These reviews show how phenomenally technological advancement has improved diagnostic accuracy and improved the clinical outcome and survival rate in CHD patients of India. The work by Taksande and Jameel pointed out that an early and accurate diagnosis with the help of some advanced imaging technique can decrease the morbidity and mortality associated with CHD (16). Against this backdrop, Sachdeva and Gupta have laid strong emphasis

on the role that continued medical education and training can play in providing health professionals with necessary skills to work with such technologies effectively .

A review by Jeremy M. Steele, Ryan A. Moore, and Sean M. Lang talks about technological advances that have really improved cardiac magnetic resonance imaging and cardiac computed tomography to benchmarks in the diagnosis and management of CHD (21). Anatomical and functional information in such minute detail through these methods serves as the very basis and foundation of any complicated surgical intervention, with subsequent follow-up. Indeed, the study by S. Finally, Rufus showed the deep learning techniques for the detection of foetal CHD using ultrasound images; therefore, opening up promising avenues for further development of diagnostic capabilities¹⁹). Even though there are several limitations to algorithm availability and its usability—with detailed physician training—the AI has its way of revolutionizing the management of CHD through streamlining diagnosis and improving outcomes for patients. According to Rufus et al., the study has been done, which shows AI's potential for detection of CHD at an early stage, which were critical for planning timely interventions and improving long-term outcomes of affected children.

Comprehensive guidelines by Anita Saxena et al. about the management of CHD in Indian children provide evidence-based recommendations about optimum timing for intervention and structured follow-up protocols (5). In light of this, these guidelines emphasize that the complete multidisciplinary care of CHD will involve a cardiologist, surgeon, and primary care provider managing the child with CHD. Meanwhile, Devyani Chowdhury et al.'s policy initiatives are original proposals for reducing healthcare disparities and improvement in the quality of multidisciplinary care through telehealth, with a view to enhancing access and quality of care delivered to CHD patients in India (23). These are precisely the kinds of initiatives that may really unearth the potential of telehealth in bridging the chasm between specialist cardiac care centres and patients located at great distances in remote or underserved areas, thereby giving all children with CHD access to timely and appropriate care.

5.2 Comparison with Relevant Studies

These findings of dissertation research are in tune with and supplement prior studies from across the world on the management of CHD and technological progress relating to cardiac diagnostics. Indeed, studies from developed countries otherwise emphasize the

lead role of advanced imaging modalities and AI-driven technologies in improving diagnosis and outcome management for CHD. For instance, international researchers like Jeremy M. Steele, Ryan A. Moore, and Sean M. Lang have illustrated the same improvement in diagnostic accuracy and patient outcomes with the incorporation of advanced imaging and AI in CHD care. The study by Steele, Moore, and Lang shows that the incorporation of innovative technologies into everyday clinical practice is important in creating dramatic and effective shifts toward more precise diagnostics and better therapeutic outcomes (21).

The survey challenges identified in this study—from healthcare infrastructure to diagnostic accessibility and policy implementation—all dovetail with results from investigations held in other LMICs beset by the same disparities. Indeed, S. and Rufus, in their piece, pointed out a possibility where AI will be valuable for enhancing the accuracy of diagnosis and accessibility to diagnosis, similar to trends globally in AI use for improved health outcomes (19). These comparative analyses underscore the universal applicability of strategies aimed at strengthening healthcare systems, improving diagnostic capabilities, and implementing evidence-based guidelines to enhance CHD management globally. It is envisioned that parallels in the Indian context draw on other LMICs in a collaborative approach toward shared challenges and leveraging technological advancement to better care for people with CHD worldwide.

5.3 Strengths of the Study

A comprehensive literature review, spanning a wide view of almost most sections of the management of CHD in India and forming part of this present work, is of great importance. This paper provides holistic insight into how recent strides are transforming CHD care across India, appraising the results from epidemiological studies, clinical reviews, technology assessments, and policy analyses in a synthesis. It will help in creating a robust analysis of the interaction among technological innovations, healthcare infrastructure, clinical practices, and influencing policy frameworks that build around the management of CHD.

Another such novelty brought by this work is that it focuses on AI-driven diagnostic technologies having the potential to revolutionize CHD care. The study will, therefore, identify emerging trends and future research directions of AI applications for the diagnosis of CHD, contributing several valuable insights into ongoing discussions

regarding precision medicine and personalized healthcare in paediatric cardiology. It charts a positive future for technologically innovative potential in transforming paediatric cardiology by elaborating on how AI can bring about improved diagnostic accuracy, and therefore facilitate early interventions.

Another strength of the study is that it Russo-PLS-based evidence-backed guidelines and policy initiatives focused on the Indian healthcare context. The comprehensive framework, therefore, provided for the optimization of CHD management within India through a review of numerous guidelines from national and international sources. It exhibits policy initiatives in this respect, thus underlining the very fact that a very supportive regulatory environment and robust healthcare policies have to be put in place if circulating biomarker-based diagnostic technologies are to be efficiently integrated into routine clinical care.

5.4 Limitations of the Study

The limitations to the dissertation are as follows: First, the fact that the review is based on already written literature carries with it the bias and limitation of retroactively analysed data, probably with varying study methodologies across the reviewed articles. This also leads to differences in design, sample size, and data collection techniques, which can pose problems for generalisability and comparability of the findings.

The scope of this review focused mainly on government measures and technical development, which might have overlooked other socio-economic factors that help explain the outcome of the management of CHD in India. There are socio-economic factors like socio-economic status, cultural beliefs, and healthcare seeking behaviour that clearly define health outcomes and access to care for patients with CHD. These said socio-economic determinants were not probed much in this dissertation and are a possible gap for further research.

Third, it is that there is potential for reduced generalizability of findings because of regional differences in health care infrastructures and in the amount of health care resources available within India. It may be assumed that the adherence level might vary between urban and rural health care facilities and even between regions with differing politics, rules, and habits concerning health care.

The fact that technological innovations and healthcare policies are changing makes it important to have continual updating and adaptation so that the present research findings remain relevant within the same period. The rapid change in technology pace and continuous evolution of healthcare policies will imply revisiting, at some point in time during its application for the management of CHD, the conclusions drawn within the study.

Lastly, with efforts to include diversity of voices and approaches, some areas of clinical management for CHD may not be as fully captured as they could have been and will, therefore, require some more research and exploration of research into issues such as the aetiology of genetic and environmental factors of CHD and the long-term outcomes of different modalities of treatment, which were not so comprehensively covered in this dissertation.

6. CONCLUSION

6.1 Summary of Findings

This dissertation has taken a critical look at the influence of recent technological changes in cardiac diagnostics on the management and outcome of CHD in India. It began with a review of the epidemiology regarding CHD in India, underlining its prevalence and the huge burden it lays on any healthcare system, especially those of low- and middle-income settings. In other words, the insights that one draws from epidemiological studies clearly underscore the need for urgent healthcare infrastructure to address the growing demand for care of individuals with CHD across the country.

In this respect, the importance of advanced cardiac imaging modalities, further including echocardiography, computed tomography, magnetic resource imaging, and AI-driven techniques in enhancing the accuracy of diagnosis and executing timely interventions for patients with CHD was discussed. The findings indicated that these technological innovations have reasonably improved clinical outcomes by way of early detection of CHD, guiding interventional surgical and non-surgical procedures, and optimizing post-operative care strategies. In addition, AI's potential role in cardiac diagnostics became a very promising frontier, with possible applications in foetal CHD detection all the way through to customized treatment planning in paediatric cardiology.

The guidelines and policy initiatives have been reviewed to know their implications toward management of CHD in India. Evidence-based recommendations brought handy insights into optimum timing of interventions, follow-up protocols, and approaches of care by a multidisciplinary team, which would help guide clinical decisions at all levels toward better patient outcomes. Key elements to improve overall quality of care for CHD in India—the reduction of inequities in healthcare, development of health-care delivery systems using telehealth, and improvement of equity of access to CHD care—have been identified.

6.2 Implications of Findings

These findings from this dissertation open up a whole host of avenues for future clinical practice, healthcare policy making, and further research at large in the management of CHD conditions in India and beyond. The first stage will see the integration of more sophisticated cardiac imaging modalities and AI-driven technologies within the routine clinic practice to bring in a sea change in the diagnosis, treatment, and long-term management of CHD. These may contribute to mitigating the morbidity and mortality toll attributed to CHD by enhancing diagnostic accuracy and the quality of clinical decisions, thus improving patient outcomes and quality of life.

It was further emphasized that the role of structured protocols and care approaches in optimizing CHD management with multidisciplinary teams remained clearly focused on evidence-based guidelines and policy initiatives. Further efforts toward their implementation at the national and regional levels remain core to standardizing care practices and reducing clinical outcome variations, if not ensuring that access to CHD services is increased and equitably provided across India's diverse socio-economic contexts.

The dissertation reveals challenges in healthcare infrastructure and disparities in the delivery of care for CHD and calls for reforms in healthcare and resource allocation strategies. Some of the critically needed steps to improve access to and affordability of care for CHD in India include strengthening of public sector capacity and building health infrastructure, coupled with augmentation of health workforce training in relatively deprived regions.

6.3 Recommendations

Based on the above findings and their implications, following recommendations are forwarded to further alleviate the management of CHD in India:

i). Promotion of Technological Integration: The institutional integration of advanced cardiac imaging modalities and AI-driven diagnostic technologies into clinical practice needs to be taken up as a priority initiative. This shall include not only infrastructure up-gradation and specialized training to health care professionals for enhancing their knowledge but also build partnerships among technology developers and researching institutions to advance the applications of CHD diagnostics.

ii). Adopting, implementing, and emphasizing evidence-based guidelines: Evidence-based guidelines, besides all the rest, for the management of CHD should be adopted and implemented essentially, and this fact has to be emphasized by healthcare policymakers and providers. The guidelines need updating and change in content to reflect developing research, technologies, and changing health needs.

iii). Strengthening Health Infrastructure: Stronger health infrastructure is called for, particularly in the rural and disadvantaged areas of the country, to make access to facilities for the diagnosis and treatment of CHD easier. This will involve the establishment of specialized centres of paediatric cardiology, procuring advanced diagnostic equipment, and recruiting trained health personnel.

iv). Promotion of Telehealth and Telemedicine: An extended role of telehealth in bridging geographic disparities to access specialist consultation or remote monitoring for CHD patients is possible. Policymakers should support initiatives aimed at promoting telehealth infrastructure and a supportive regulatory framework for telemedicine practices, working towards fixing issues regarding digital connectivity in remote areas.

v). Investments in Research and Innovation: Continued investment into research and innovation will remain core to driving further improvements in CHD diagnosis, treatment options, and prevention strategies. Collaborative research efforts between academia, healthcare providers, and industry stakeholders will accelerate the creation of novel technologies, new types of therapeutic interventions, and tailored options for healthcare delivery to a growing population afflicted by CHD.

6.4 Conclusion

This dissertation has been an effort at bringing on board a critical review of revolutions cardiac diagnostic technology has brought into the landscape of treatment for CHD care in India. The insistence, by synthesizing evidence on epidemiological studies, technological assessment, guidelines, and policy analyses, accrues to the cardinal position accorded to advanced imaging modalities, AI-driven technologies, the evidence-based guideline-making process, and policy initiatives toward better CHD care delivery and patient outcomes.

These, moving ahead, would have to be attended to vis-à-vis the identified recommendations and challenges if there has to be any progress toward better CHD

management practices, enhanced infrastructure for healthcare, and high-quality care that is equitably distributed to all patients with CHD in this country. These work together toward the desired ends by welcoming stakeholder collaboration, leveraging technology advances, evidence-based strategies, and multi-disciplinary inputs.

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